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Competitive search equilibrium with multidimensional heterogeneity and two-sided ex-ante investments

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Abstract

We analyze a competitive (price-taking) search model where workers and firms make costly investments (e.g. in education and physical capital, respectively) before they enter the labor market. The environment features transferable utility and symmetric information. A key novelty with respect to existing work is that we allow for multidimensional heterogeneity on both sides of the market. The probabilities of finding and filling different jobs and the corresponding wages are determined endogenously in equilibrium. We show that constrained efficient allocations can be determined as optimal solutions to a linear programming problem, whereas the prices supporting these allocations and the associated expected payoffs for workers and firms correspond to the solutions of the ‘dual’ of that linear program. We use this characterization to show that an equilibrium exists and is constrained efficient under very general conditions. The fact that linear programming techniques are used for the structural estimation of frictionless matching models suggests that our framework is potentially useful for empirical studies of labor markets and other markets where search frictions are prevalent.

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1. Introduction

We analyze a competitive search model with transferable utility where workers and firms make productive investments before they enter the labor market. We show that a competitive search equilibrium exists and is constrained efficient under very general conditions. In particular, we allow for multidimensional heterogeneity on both sides of the market—a feature which is the norm in applied work. The “trick” is to write the competitive search model as one of general equilibrium. Jerez (2014) makes a similar point in the context of a model where all the match-relevant characteristics of the traders are exogenous. Here we extend the analysis by allowing agents to enhance their productive attributes ex-ante.

Competitive search models are known to deliver constrained efficient outcomes in a variety of settings.¹ In particular, they solve the familiar “hold-up problem”. This point has been made by Acemoglu and Shimer (1999b) in a model with transferable utility and one-sided investments (in capital) by firms, and by Masters (2011) in a model variant where workers also make investments (in education).² While these papers assume homogeneous workers and firms, Shi (2001) obtains the same result in an extension of Acemoglu and Shimer’s model where workers are heterogeneous in their skills. In all three papers the observability of the agents’ investments and of their match-relevant characteristics – which rules out asymmetric information problems – is crucial for the efficiency result. We extend the efficiency and existence results in these papers to a general setting which combines two-sided ex-ante investments with heterogeneity. A novelty with respect to Shi (2001) is that heterogeneity is two-sided and multidimensional (rather than one-sided and one-dimensional); and a novelty with respect to all three papers is that we allow investments to be multidimensional as well.

Our framework can be viewed as embedding the classical hedonic model of Rosen (1974) and Lucas (1977) into the competitive search formulation. As noted by Lucas (1977), a distinguishing feature of labor markets is that, just like the firms’ payoffs depend on the match-relevant characteristics of the workers they hire, the workers’ payoffs depend on the hedonic attributes of the jobs they perform. In our setting, workers differ in several exogenous characteristics and may invest in a list of productive attributes before they apply for a job. Firms can also make multidimensional investments (e.g. in technology, equipment type, ...) prior to hiring their employees. Firm investments affect the value of employing different kinds of workers,³ and may also affect the hedonic attributes of the jobs firms create.⁴ The hedonic wage function and the probabilities of filling and finding different jobs are determined endogenously in equilibrium. The class of economies we study is large: we allow for general production, utility and matching functions,

¹ See Montgomery (1991), Moen (1997), Shimer (2005), Acemoglu and Shimer (1999a, 1999b), Julien et al. (2000), Shi (2001), Eeckhout and Kircher (2010), and Masters (2011), among others. By contrast, the classical Diamond–Mortensen–Pissarides random search and bargaining model features bilateral monopoly power, so (in general) it does not lead to constrained efficient outcomes. Neither do price posting models a la Burdett and Mortensen (1998), which also feature imperfect competition. See Rogerson et al. (2005) for a comprehensive survey of the labor search literature.

² See, by contrast, the random search and bargaining models of Acemoglu (1996) and Masters (1998).

³ In certain jobs (involving routine or easy to automate tasks), investments in computerization make it easier to replace workers with machines. This in turn increases the worker’s returns from investing in attributes which are complements to (rather than substitutes for) the new capital. Deming (2017) finds evidence that social skills have been increasingly rewarded by the market in past decades, especially when combined with cognitive skills.

⁴ Advances in information and communication technology tend to increase job rotation and the degree of worker multitasking (see Deming, 2017). Firm investments can also affect working conditions, and even job location (e.g. increasing computerization allows working from home in some occupations).

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